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# Cloth Houses

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# CLOTH HOUSES

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## INTRODUCTION

The summer culture of cut flowers of a superior quality for commercial sale is not always satisfactory because of the difficulty of control of environmental factors. The introduction of cloth-covered houses for this purpose has been an aid in securing better quality, as well as a means of lessening the destruction from insects and diseases. During periods of dry weather, growth may be controlled to some extent by the use of irrigation, but the light intensity, humidity, and temperature are more difficult to regulate. For this reason the cloth house offers an opportunity to improve the quality, as well as quantity, of the flowers by controlling to a partial extent at least these factors, as well as the soil moisture. Insects are more easily checked under a cloth house and the plants are not attacked by those pests that migrate from one plant to the next. The cloth house excludes bees and other insects whose activities in the pollination of flowers cause them to mature quickly and lessen their keeping qualities. Flowers are not injured by heavy rains when grown under cloth, and there is less splashing of mud on the foliage and flowers than occurs out of doors. All these factors help to improve the quality and quantity of cut flowers grown in a cloth house over those grown out of doors.

In 1926 Kunkel (6) published the results of a study of the virus disease, aster yellows, in which he stated definitely that it was transmitted only by the leaf hopper *Cicadula sexnotata* Fall. This leaf hopper does not fly higher than 6 feet, and the first means of control was the use of wire screens or cloth walls for protection. This was not entirely satisfactory, because many insects were blown over the walls and they spread the disease.

ones and Riker (5), working in Wisconsin on aster diseases, constructed the first cloth house with both the top and sides covered for their studies. They followed Kunkel's findings which stated that the leaf hoppers would not pass through a wire mesh screen of 18 wires to the inch. There was available on the market at that time the cloth used by the tobacco growers of Connecticut Valley; it had 22 threads per inch. This material was used in the construction of their cloth houses and cages and was found to keep out all leaf hoppers. Experiments were carried on in which cloth of a coarse texture was used, but it was not found to give a satisfactory screen to keep out the leaf hopper.

## FACTORS INFLUENCING GROWTH UNDER CLOTH

It is important that some consideration be given to the environmental factors which influence growth in the cloth house. These factors include light, temperature, humidity, moisture, soil, and nutrients. Under cloth, the soil and its component parts are no different from similar plots outside and, hence, play no part in the explanation of the responses secured. Light, temperature, and relative humidity, however, do play an important role.

### *LIGHT*

Light is necessary for all plant growth. It influences the development of chlorophyll, the green color pigment, and the process of photosynthesis, which is the manufacture of sugars and starch in the plant by the action of the light

on the chlorophyll together with water and carbon dioxide. In addition to its influence on chlorophyll and food materials, light affects the morphology or structure of the plant tissues. The work of several investigators indicates that there is an optimum light intensity for each species of plant and that ultraviolet light produces an increased growth on some plants and has no effect on others. The length of exposure of a plant to light is important in some plants in determining the type of growth which the plant will make, whether a vegetative or reproductive type. The work of Garner and Allard indicated very strikingly this effect of light, and the more recent work of Laurie and Poesch (12) and others has made this phenomenon of "photoperiodism" of practical commercial importance.

Tests were conducted in 1932 with slowly sensitized paper to record the light intensity. A reduction of 12 units in intensity was obtained under yellow cloth, a reduction of 6 to 8 units, under white cloth, as compared with the light intensity outdoors. The difference between the two cloths varied from 4 to 10 units, depending upon the intensity of light in the open. When this intensity was high, the difference between the two cloths was greater than when the intensity was low.

In 1933 a similar test was made using a Weston Illuminometer which records light intensity in foot-candles. Preliminary work showed that the instrument must remain in the same relative position to the source of light for accuracy. A slight change in the angle at which the meter was held in relation to the rays of the sun caused a variation in the readings. No difference in readings was noted whether the reading was made 3 feet or 6 feet from the cloth. Readings close to the cloth showed an increase in the foot-candles when compared with readings taken 3 feet from the cloth.

In order to obtain comparable readings, small portable enclosures 3 feet square were used. The Weston Illuminometer was placed in a horizontal position 3 inches from the ground and readings were taken by placing these enclosures over the instrument. Readings were made just before placing the enclosure over the meter, while the enclosure was over it, and just after it was removed. White, yellow, and red cloths were used in this comparison. The readings were made outdoors in full sun and in a well-lighted greenhouse workroom with light coming in from the windows at the ridge, as well as the sides. The average of a number of readings was taken in each case. The results secured are presented in Table 1.

**TABLE 1.—A Comparison of the Percentage Reduction in Light Intensity**

| Cloth | Laboratory conditions | | Full sunlight | |
|---|---|---|---|---|
| | Foot-candles | Reduction per cent | Foot-candles | Reduction per cent |
| None | 44.7 | 0.0 | 11,500 | 0.0 |
| White | 37.2 | 16.8 | 7,475 | 35.0 |
| Yellow | 32.0 | 28.4 | 6,900 | 40.0 |
| Red | 25.3 | 43.4 | 6,035 | 47.5 |

From the data presented it can be seen that there is a marked reduction in the intensity of light which is available to plants growing under cloth. The increased stem length and greater size of plants under cloth are probably due to a large extent to the reduced light conditions.

## *TEMPERATURE*

In 1933 readings were made of variations in the temperature outdoors and under cloth. Differences of from 30° F. cooler under cloth to 5.5° F. warmer were recorded. The average of all readings did not show at any time a greater difference than 1.8° F. under cloth.

Continuous temperature records were made during July and August, 1936, with Taylor Thermographs both outdoors and under cloth. These instruments were in sheltered cases which allowed free air circulation.

The temperature curves obtained under cloth and outdoors during those 2 months were very similar. The temperature under the cloth varied from the same as outdoors to 8° F. cooler under cloth when the temperature reached its highest between 2:00 P. M. and 5:00 P. M. The temperature during these 2 months reached its coolest between 5:00 A. M. and 7:00 A. M. The temperature change under cloth seemed to lag behind out-of-doors changes about ½ to 1½ hours. This is to be expected, because the cloth tends to hold the heat in the house and since the air movement is less, the change of air will be somewhat slower. The temperature at the coolest period of the day was the same or very nearly so both under cloth and outdoors. These differences in temperature are not great enough to account for all the difference in growth, and yet less heat obtained under cloth during the hottest periods of the day. From these data, temperature reductions seem to be a factor in producing favorable growth under cloth.

## *RELATIVE HUMIDITY*

The moisture that is in the form of vapor in the air is termed humidity. It is one of the important factors, because it affects the rate of transpiration, or loss of water from the plant through the leaves.

By relative humidity is meant the ratio of the amount of water vapor in the air at a given temperature and pressure to the amount that is necessary to saturate it under these conditions. Wind, temperature, air pressure, altitude, exposure, soil moisture or water content, and plant covering all affect the humidity of the air. The effect of humidity is very important in the study of the natural distribution of plants, and this determines to some degree the cultural practices that will be necessary under greenhouse or garden conditions. The humidity is generally lower during the day and higher at night. Its effect is most important during the day, when the temperature is greatest and the transpiration or loss of water is at the maximum. It is because of this that we may have wilting of the plant even when the soil is moist. The loss of water is going on at such a rapid rate that the roots are not able to take up water fast enough to keep up with the loss, and wilting results. Where the humidity is greater; that is, the air contains considerable water vapor, the transpiration is slowed up.

A study was made to determine whether or not the difference in the humidity under cloth and outdoors was sufficiently great to influence the more favorable growth in the cloth house. In 1933 the relative humidity was determined in July and August by the use of a sling psychrometer taking readings at four different times during the day. The data obtained are shown in Table 2.

TABLE 2.—Relative Humidity, 1933

| Time of day | Outdoors | Under yellow cloth | Under white cloth |
|---|---|---|---|
| 8:00 A. M. | 74.1 | 74.6 | 72.6 |
| 10:00 A. M. | 49.2 | 52.1 | 49.0 |
| 12:00 M. | 50.0 | 52.0 | 52.9 |
| 2:00 P. M. | 45.0 | 51.1 | 48.1 |

The relative humidity under cloth and outdoors was very nearly the same in the morning but was somewhat higher under cloth in the day.

During July and August, 1936, constant humidity records were obtained with the use of hydrographs which were placed in the same shelters under cloth and outdoors as the thermographs. The average relative humidity outdoors between 8:00 A. M. and 8:00 P. M. in July was 35.8, in August, 47.4; under cloth in July it was 38.0 and in August, 49.1. From these figures it is shown that the relative humidity is somewhat greater under cloth than out of doors. In July the difference was 2.2 and in August, 1.7. This very slight difference in relative humidity may seem hardly great enough to be considered important in producing the more favorable growth under cloth. Yet it should be realized that movement of air is reduced under cloth, so that even were the humidity under cloth exactly that of outdoors, there would still be considerable reduction in transpiration.

Repeated tests with amounts of water required for equivalent areas under cloth and out of doors indicated that under the general sunny conditions of the average summer, three times less water was required under cloth than out of doors. Although the actual saving of water may be important, the fact that greater uniformity of soil moisture results is a factor of greater importance in promoting optimum growth.

A summation of the factors influencing the development of plants under cloth indicates that reduced light, reduced temperature, slightly higher humidity with slow air movements, and uniformity of soil moisture are the most important.

## THE EFFECT OF THE COLOR OF THE CLOTH

Because previous experimental work had shown that the use of a cloth enclosure was practical for the commercial production of asters, it was deemed advisable to determine whether or not the color of the cloth used had an influence on the plant growth. In 1932, two colors of cloth were used, yellow and white. Both cloths had a mesh of 22 by 22 threads per inch. One-half of the experimental house (32 feet by 95 feet) was covered with white cloth and the other, with yellow cloth.

In 1933, six small cloth houses were erected and covered with white, yellow, blue, green, red, and brown cloth. There were some slight differences noted, but these are not submitted here, because with the exception of the white and yellow, the cloths faded badly within 6 weeks after being erected.

## LOCATION OF THE CLOTH HOUSE

One of the first things to be considered in erecting a cloth house is the location. The house should, if possible, be located fairly close to some building or tall trees for protection from winds. The protection should be on the side of

the prevailing winds. In Ohio, this is generally the west or northwest. The cloth house should not be located so close to the windbreak that there is a shadow over it. When it becomes necessary to erect a cloth house near a large tree, the house should not be placed so that the tree casts a shadow over the house or the roots come in competition with plants of the cloth house. In most cases the cloth house should be located reasonably close to the greenhouses or service buildings for convenience.

It is necessary to provide a water line with several faucets for hose attachments. The number will vary with the size of the house, but they should be placed so that each bed can be watered efficiently. In a house 33 feet wide and 100 feet long with five beds across the house, two openings placed in the center of the house at the cross walks are sufficient.

Where an electric spray pump is used it is necessary to install an electric outlet in the cloth house. This may also be used for lights if it is necessary to do any work at night, such as using certain spraying materials that would cause damage if applied to the plants during the heat of the day.

The area surrounding the cloth house should be kept free of weeds and trash. It is in such material that a large number of insects and disease pests are harbored and often winter over to infest the plants in the spring. The cloth will exclude the majority of troublesome insects, but as a precautionary measure the area around the house should be kept free of weeds.

## PREPARATION OF THE SOIL

The soil in the cloth house should be as well prepared as the soil used in the greenhouse. It is advisable to prepare the soil the season previous to the erection of the cloth house. First, however, the soil must be well drained. If it is poorly drained, some provision should be made either for surface drainage or the use of tile. Where the cloth house is to be erected without preparing the soil the year previous, an application of well-rotted manure should be used. This is applied over the area of the cloth house to a depth of 2 or 3 inches and thoroughly worked into the upper 6 or 8 inches of soil. At the same time, any fertilizers that are necessary should be applied, particularly where either phosphorus or potassium is lacking. Phosphorus is supplied in the form of superphosphate at the rate of 5 to 10 pounds to 100 square feet, and potassium at the rate of 1 pound to 100 square feet in the form of muriate of potash.

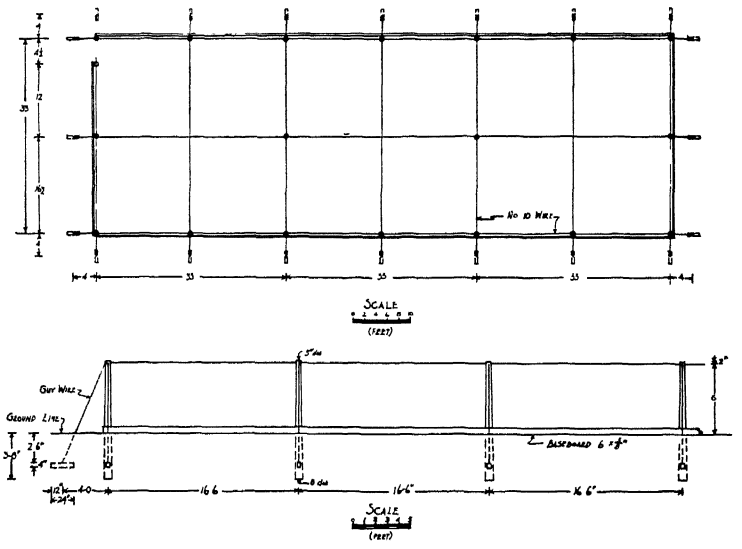
Where the soil for the cloth house is prepared the year previous to its use, green manure crops should be used. In the spring a cover crop of any of the following is suitable: soybeans sown May 15 to June 10 at the rate of 2 bushels per acre, Sudan grass sown May 20 to June 20 at the rate of 20 to 25 pounds per acre, or corn broadcast April 25 to May 25 at the rate of 1½ to 2 bushels per acre. These crops are plowed under in August and followed by another crop to be left until spring. In early September a crop of rye or wheat is sown at the rate of 8 to 10 pecks per acre; at the same time an application of a fertilizer, such as 4-12-4, 4-16-4, or 2-12-6, at the rate of 600 to 800 pounds per acre is made. These crops are left until April. Then they are plowed under; the beds are prepared for planting; and the cloth house is erected. Following such a procedure the soil is left in a very good condition to hold water and supply nutrients to the plant, as well as conserve those materials that are already present.

## CONSTRUCTION

The construction of a cloth house is simple, and it does not require any special equipment or material. The cloth used to cover the house is made in widths of 33 feet 4 inches. To be economical in the use of cloth the house is made 33 feet or its multiple wide and of any length that is desirable. The 33-foot-wide cloth allows several inches of extra material for wrapping around the wire and sewing.

The size of the cloth house should be laid out on the ground; the corners must be square. The corner posts are then set so that the outside face is exactly the width of the house. The other posts are spaced to center at 16 feet 6 inches to carry the side and cross wires. For a house 33 feet wide, center posts may not be necessary, but for wider houses they are essential to carry the greater load, as well as a wire on which to sew the cloth. In building a house of more than one 33-foot width, it is necessary that the posts be set to the exact measurements.

The posts should be of a good grade of yellow pine, chestnut, or redwood. They may be treated with some wood preservative before they are set to lengthen their life. Old 3-inch iron pipe or boiler tubes may be used and set in concrete if more permanent construction is wanted. The posts or pipe used should be as smooth as possible to prevent the cloth from tearing where it comes in contact with them.




PLAN AND ELEVATION OF ASTER HOUSE.

**Fig. 1.—Plan of construction of a cloth house 33 feet by 99 feet**

The posts are set in the ground 4 feet deep and 6 feet 8 inches aboveground. This will make the side walls 6 feet high and allow 8 inches above the posts to which to attach the guy wires. The outside posts should be guyed rigidly to hold the house securely. This is done by digging a hole 4 to 5 feet away from the post and burying a piece of wood or other object as a "dead man" for fasten-

ing the guy wire. A more permanent type of construction may be had by digging the hole, then pouring concrete in to fill the hole partly or to the ground level, and inserting a screw eye or screw hook in the center for fastening the guy wire. The guy wire is cut about 16 feet long and doubled. One end is fastened securely to the top of the post by staples and the other end is fastened to the "dead man". To tighten the wire a small stick is placed between the wires and twisted. This will take up the slack, as well as tighten the wire, and may be used to adjust it from time to time. Turnbuckles may be put into each guy wire for the same purpose. The corner posts will require a guy wire pulling against each side of the rectangle. The center posts are set so that they are just 6 feet high. The cross wires are fastened on the top of these posts.

A convenient place should be selected for the location of the door or entrance. It is placed either at a corner or near one of the side posts. It should be located so that there is little inconvenience in getting sprayers, wheelbarrows, or other material or equipment into or from the house. The post should be set to provide a door 3 to 3½ feet wide.

The baseboard is next fastened around the house on the outside of the posts. This should be of sound lumber 1 inch by 6 inches or 1 inch by 8 inches. After the baseboard has been installed it should have the soil banked up against it to prevent insects from entering the house beneath it.

A No. 8 galvanized wire is strung around and fastened to the posts 6 feet above the ground. The amount of No. 8 wire necessary may be estimated on the basis of 14 feet to the pound.

Some growers have found it more satisfactory to run the wire through a hole in the post rather than staple it on the outside of the posts. Either method is preferable to running the wires over the top of the post, as this allows the cloth to come in contact with the top and become loose and torn.

## *SEWING THE CLOTH*

Before the cloth is sewn a piece of old rubber tubing should be placed over the posts where they come in contact with it. This should include side posts, corner posts, the tops of the center posts, as well as a collar around each side post where the wire and cloth come together at the top.

A calm day should be selected for sewing the cloth, as it is difficult to cover evenly and tightly when a wind is blowing. From one end of the house, the cloth is unfolded over the wires so that it will lie in a long strand from one end of the house to the other. The cloth for the side walls is next stretched along the side on the ground. The top piece of cloth should extend over the end about 1 foot in order that there will be enough to wrap around the wire and sew. The next step is to take the edge of the top cloth and the edge of the side wall, place them together, roll them several times around the wire, and fasten them with clothespins. This is continued until about 10 feet are pinned. It should be made certain that the reinforcing ribs of the cloth are at right angles to the wire. It is then ready to be sewn. The common lock stitch is used because it holds the cloth firmly and is easily made. A good grade of cotton twine or string doubled should be used. The needle used in sewing is a large straight needle or a miller's needle that is slightly curved. The stitches should be 3 to 4 inches long. The top cloth should not be pulled too tight lengthwise of the house during the sewing. At the beginning of the sewing the needle is threaded and the end of the thread is securely fastened to the end post, wrapped around the post several times, and then tied. As the sewing proceeds, the clothespins are removed.

If the house is 66 feet wide or more the first step is to sew the two top pieces of cloth together along the center wire and then proceed as before.

An important precaution to follow in sewing is to keep the reinforcing ribs of the cloth running at right angles to the wires; otherwise the cloth may be pulled out of line and not cover the top.

The next step is to fasten the side walls to the baseboard with lath or a narrow strip of wood. Individual nails having large heads or a cardboard or tin disk for a head may be used. It is often desirable to paint the baseboard and cloth to prevent rotting near the ground and the wind from tearing or pulling the cloth. A cloth, specially made for the purpose, has brass eyelets at the base in the reinforcement rib. This is attached by driving a four penny nail into the baseboard at an angle and slipping the eyelet over it. It has the added advantage that the side wall may be loosened and raised if it is necessary to carry in fertilizer or soil.

## LAYOUT OF THE CLOTH HOUSE

The beds are laid out lengthwise in the house. This method provides for the most economical use of the ground area. The width of the beds may be made to any dimension, but in general, five beds each 54 to 56 inches wide are used in a 33-foot house. This width is most convenient for planting, cultivating, watering, and fertilizing. Such an arrangement allows for five walks 18 inches wide and a main walk 26 inches wide. In all cases the center walk or the one opposite the entrance should be wider than the remaining walks, to provide for easier movement in the house, as well as to accommodate a sprayer or wheelbarrow. The walks across either end of the house should be at least 2 to 2½ feet wide.

The plants may be planted directly in the ground at the established level or in shallow beds provided by the use of a 6-inch board placed 1 or 2 inches into the ground around the border of each bed, with the remainder left to form the sides of the bed. The board keeps water from running into the walks and also prevents the plants along the sides of the bench from drying out rapidly.

In a house 100 feet long no cross walk is necessary, especially if only one or two different crops are grown, but in longer houses cross walks should be provided across the center of each bed. Supports similar to those used in the greenhouse should be provided for each crop. Iron pipes or 2 by 4 – inch posts 6 feet long are used. These are set about 2 feet in the ground at the corners of each bed, and crossbars of wood or pipe are used for fastening the wires. Smaller posts of 2 by 2 – inch or ½- to ¾-inch pipe are used at intervals of 8 to 10 feet in the bed to provide support for the wires. These supports should be put in place before the house is covered with the cloth.

## EXPERIMENTAL RESULTS WITH ASTERS

### *ASTERS UNDER WHITE AND YELLOW CLOTH*

The culture of asters (*Callistephus chinensis*) is rather difficult because of their susceptibility to two diseases: aster wilt and aster yellows. Because of this, wilt-resistant strains were used in comparison with nonresistant ones. These were grown under white and yellow cloth and out of doors. In 1932 the seed was sown April 15; the plants were pricked off into 2½-inch pots and planted on May 21 in the cloth house. The plants were set in beds and planted 12 by 12 inches.

Under cloth the asters needed supports similar to those used for carnations or snapdragons in the greenhouse. The plants received regular fertilizer applications and the normal cultural attention. Table 3 gives the results obtained with the 22 varieties of asters used in this experiment.

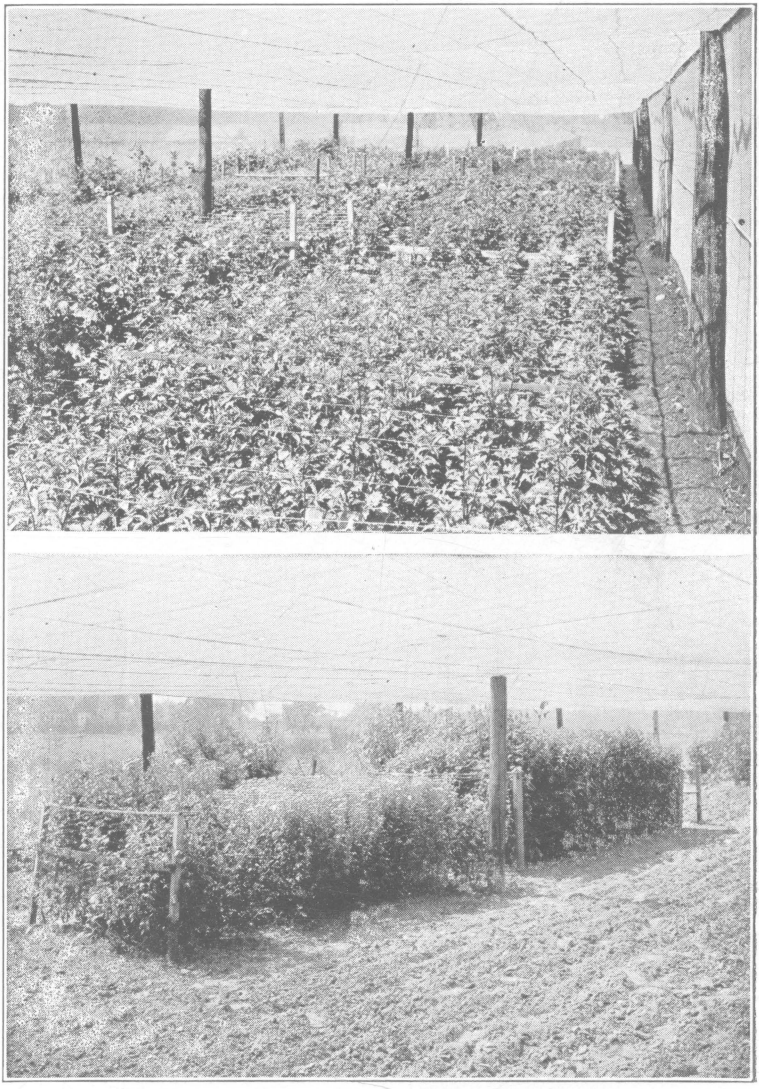


**Fig. 2.—Top—Asters growing under cloth; in the background pompon chrysanthemums and miscellaneous annuals. Bottom—Pompon chrysanthemums shaded and not shaded. Plot in the foreground shaded and in flower. Plot in the background, not shaded, plants taller in growth and several weeks later in flowering**

## TABLE 3.—Comparison of the Production of Disease-resistant and Nonresistant Strains of Asters Grown under Yellow Cloth, White Cloth, and Outdoors

| Variety | Wilt resistance | | | Average number of flowers per plant | | | Average stem length | | | Average flower diameter | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Yellow | White | Open | Yellow | White | Open | Yellow | White | Open | Yellow | White | Open |
| | *Pct.* | *Pct.* | | | | | *In.* | *In.* | *In.* | *In.* | *In.* | *In.* |
| Ball's White (nonresistant) | 71 | 60 | * | 7.2 | 5.9 | 0.3 | 27.3 | 21.6 | 15.1 | 3.6 | 3.3 | 3.0 |
| Ball's White (resistant) | 40 | 25 | | 3.3 | 3.1 | ..... | 28.2 | 20.0 | ..... | 3.5 | 3.3 | ..... |
| Crego Shell Pink (nonresistant) | 85 | 91 | | 3.2 | 7.4 | ..... | 31.2 | 25.6 | 21.5 | 4.0 | 3.6 | 4.0 |
| Crego Rose Pink (nonresistant) | 71 | 62 | | 7.7 | 6.9 | ..... | 28.9 | 24.1 | ..... | 3.5 | 3.3 | ..... |
| Crego Deep Rose (resistant) | 62 | 60 | | 5.9 | 6.4 | .3 | 28.7 | 28.6 | 13.1 | 3.4 | 3.5 | 3.3 |
| Early Royal Purple (nonresistant) | 100 | 88 | | 26.6 | 16.7 | 6.3 | 18.4 | 22.3 | 16.0 | 2.5 | 2.8 | 2.5 |
| Early Royal Purple (resistant) | 87 | 100 | | 16.9 | 18.7 | 9.6 | 24.6 | 22.7 | 18.0 | 2.7 | 2.6 | 1.9 |
| Queen of the Market Purple (nonresistant) | 100 | 100 | | 13.8 | 14.3 | 8.6 | 19.2 | 17.6 | 16.0 | 2.5 | 2.3 | 1.7 |
| Queen of the Market Dark Blue (resistant) | 100 | 100 | | 14.2 | 16.8 | 9.5 | 22.7 | 22.1 | 15.6 | 2.2 | 2.2 | 2.0 |
| Astermum (resistant) | 90 | 60 | | 14.2 | 14.9 | 2.6 | 24.8 | 20.2 | 14.0 | 3.1 | 2.9 | 2.9 |
| Amer. Branching Semple Pink (resistant) | 56 | 60 | | 6.2 | 7.3 | .3 | 26.4 | 25.6 | 11.6 | 3.3 | 2.9 | 3.0 |
| Amer. Branching Azure Blue (resistant) | 36 | 43 | | 3.9 | 4.9 | ..... | 27.7 | 24.5 | ..... | 3.3 | 2.8 | ..... |
| Amer. Branching Phlox Pink (resistant) | 33 | 80 | | 4.7 | 5.5 | ..... | 26.2 | 23.2 | ..... | 3.0 | 3.0 | ..... |
| Calif. Giants Light Blue (nonresistant) | 53 | 60 | | 3.5 | 4.8 | ..... | 26.3 | 25.5 | ..... | 3.7 | 3.5 | ..... |
| Calif. Giants Dark Purple (nonresistant) | 30 | 30 | | 2.5 | 4.2 | ..... | 24.9 | 24.0 | ..... | 3.2 | 2.9 | ..... |
| Early Beauty Crimson (resistant) | 67 | 66 | | 5.6 | 7.1 | ..... | 32.8 | 30.1 | ..... | 3.0 | 2.7 | ..... |
| Ostrich Feather Deep Rose (resistant) | 26 | 40 | | 2.5 | 4.1 | ..... | 29.6 | 29.2 | 12.0 | 3.7 | 3.6 | 3.5 |
| Comet Pink (resistant) | 80 | 97 | | 16.0 | 18.4 | 2.1 | 22.1 | 21.6 | 14.0 | 3.0 | 3.0 | 2.5 |
| New Giant Calif. Sunshine (nonresistant) | 77 | 90 | | 8.2 | 8.0 | .1 | 24.9 | 24.3 | 13.5 | 3.2 | 3.0 | 3.0 |
| Vaughan's Sunshine (nonresistant) | 37 | 96 | | 10.5 | 20.5 | .9 | 23.8 | 24.8 | 14.0 | 3.0 | 2.8 | 2.5 |
| Heart of France (nonresistant) | 57 | 83 | | 7.4 | 11.4 | ..... | 23.7 | 23.5 | 10.5 | 2.6 | 2.6 | 2.5 |
| Heart of France (resistant) | 77 | 77 | | 10.2 | 8.4 | ..... | 21.3 | 23.7 | 12.0 | 2.7 | 2.7 | 2.7 |

*Plants were removed before wilt was present because of the presence of yellows.

No aster yellows was noted under the cloth enclosure; whereas the entire crop in the field, with the exception of such early varieties as Queen of the Market, Early Royals, Astermum, and Comet Pink, was destroyed by the disease.

In Table 3 the average number of flowers per plant represents the total number cut from each plot divided by the number of plants originally in the plot. This average would have been higher had there not been any wilt present. The stem length and flower diameters were larger under the yellow cloth than under the white, but both exceeded the stem length and diameter of those grown out of doors. The earlier varieties, such as Queen of the Market, Early Royals, Astermum, and Comet Pink, produced the largest number of flowers per plant. The quality of these early flowers was poorer than that of the later flowering types.

In 1933 a similar experiment was conducted with asters. Since the results of the year previous seemed to indicate that yellow cloth was slightly more beneficial in securing better flowers, the position of the white and yellow cloth was reversed. In this way a check was made to determine whether differences under the cloth might have been due to soil variations or whether they were due to the color of the cloth. The soil in the whole house was of the same texture and series (Fox Silt Loam), and the variation in the area of the house was very little. Table 4 gives the results of the experiment. No plants were grown out of doors because of the prevalence of insects injurious to the aster.

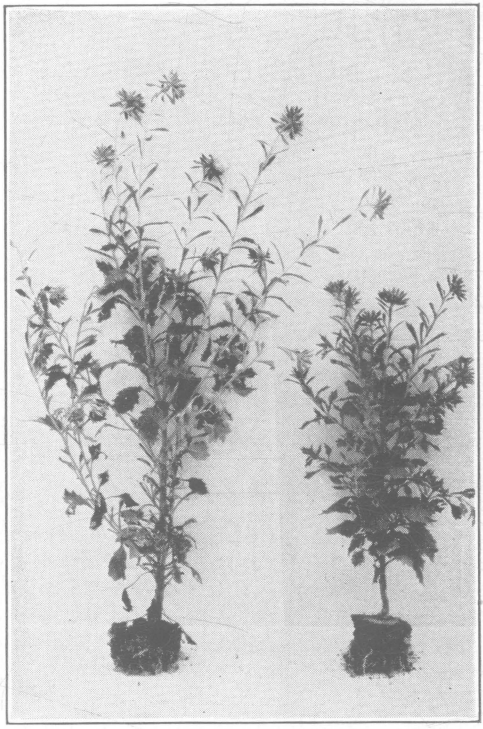


**Fig. 3.—Asters under cloth and without protection. Left—Grown under cloth Right—Grown out of doors**

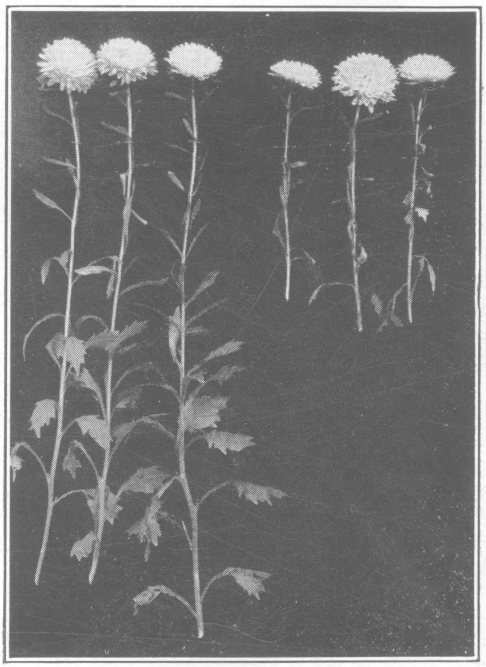


**Fig. 4.—Aster variety Royal Azure Blue**
**Left—Grown under cloth enclosure**
**Right—Grown without protection**

In Table 4 the results show a difference of 4.4 per cent in stem length obtained in favor of white cloth. The diameter showed a difference of 1.4 per cent in favor of the yellow cloth. These differences, however, are not great enough to be significant.

Asters growing under cloth need supports, similar to those used in greenhouses for snapdragons and carnations.

Less frequent watering is necessary under cloth houses.

The color of the flower is considerably better under the cloth, being darker and more intense.

There was a slight but not significant variation in stem length between white and yellow cloth.

## *REDUCTION OF DAYLIGHT PERIOD ON ASTERS*

The preliminary work on shading asters was done during the season of 1933. This was to determine whether or not late-blooming varieties of aster, *Callistephus chinensis*, will respond to shading or the artificial shortening of the day length. The variety Ball's White was used. These plants were grown under both white and yellow cloth. The plants were shaded from August 2 to August 30. This was done by covering the plants with a black cloth shade, Ohio Style No. 375, at 5:00 P. M. and removing it at 7:00 A. M.

## TABLE 4.—Comparison of Asters Grown under Yellow and White Cloth

| Asters | Per cent of wilt resistance | | Average flowers per plant | | Average stem length | | Average diameter | |
|---|---|---|---|---|---|---|---|---|
| | Yellow | White | Yellow | White | Yellow | White | White | Yellow |
| | | | | | *In.* | *In.* | *In.* | *In.* |
| American Branching Azure Blue | 87.76 | 94.43 | 11.07*<br>9.10* | 6.15*<br>5.90* | 21.31 | 23.60 | 2.85 | 2.81 |
| American Branching Semple Pink (resistant) | 97.62 | 97.62 | 12.85*<br>12.33* | 11.96*<br>11.47* | 20.33 | 23.17 | 3.01 | 2.96 |
| Astermum (resistant) | 92.86 | 92.86 | 12.67*<br>11.57* | 11.69*<br>10.67* | 20.01 | 21.19 | 2.66 | 2.61 |
| Ball's Purple (resistant) | 100.00 | 100.00 | 13.33*<br>13.33* | 10.60*<br>10.60* | 23.69 | 25.17 | 2.94 | 3.13 |
| Ball's White (resistant) shaded | 95.24 | 80.95 | 8.00*<br>7.62* | 8.80*<br>7.14* | 25.93 | 28.34 | 2.79 | 2.67 |
| Ball's White (resistant) not shaded | 92.86 | 78.57 | 7.63*<br>7.10* | 7.65*<br>6.07* | 23.62 | 26.60 | 2.89 | 2.80 |
| Crego Deep Rose (resistant) | 95.24 | 95.24 | 9.30*<br>8.86* | 8.40*<br>8.00* | 25.21 | 24.87 | 3.33 | 3.22 |
| Giant Branching Phlox Pink | 95.83 | 83.33 | 15.09*<br>14.46* | 13.35*<br>11.13* | 22.43 | 21.70 | 3.14 | 3.10 |
| Resistant Heart of France | 100.00 | 95.83 | 10.75*<br>10.75* | 10.30*<br>9.88* | 22.42 | 23.68 | 3.81 | 2.74 |
| Royal Azure Blue | 100.00 | 97.62 | 13.21*<br>13.21* | 10.51*<br>10.26* | 23.15 | 19.84 | 2.88 | 2.86 |
| | | | | | 228.00 | 238.16 | 29.30 | 28.90 |
| | | | | | In favor of white, 4.4 per cent | | In favor of yellow, 1.4 per cent | |

*Upper figures on surviving plants; lower figures on total plants.

A very striking increase in earliness was observed. The shaded asters matured 96.8 per cent of the flowers before September 1; whereas the normal asters matured but 44 per cent. The quality was better in the shaded asters and the stem length and production were equally as good.

Table 5 gives the date of flowering of this preliminary shading experiment with aster, Ball's White.

**TABLE 5.—Preliminary Results of Shading**

| Asters | Under | Number of flowers cut | | | |
|---|---|---|---|---|---|
| | | Aug. 13-20 | Aug. 21-27 | Aug. 28-31 | Sept. 1 |
| Shaded | Yellow cloth | 9 | 85 | 56 | 10 |
| | White cloth | 10 | 61 | 79 | 0 |
| Not shaded | Yellow cloth | 7 | 27 | 49 | 123 |
| | White cloth | 8 | 27 | 50 | 91 |

In 1934 a more extensive experiment was conducted with asters to bring about earlier flowering. This was conducted under yellow cloth. Seven varieties of asters were used in this experiment. These plants were planted in the cloth house on May 18 and then given normal care and cultivation. Each variety was divided into four plots. One plot was allowed to come normally and flower; the other plots were shaded to reduce the day length. The shading began on June 20, June 27, and July 4. Shading was continued until the majority of the flower buds showed color.

Table 6 gives the results of this investigation.

A comparison was made in 1937 between short-day treatment and lighting of asters in the seedling stage. The variety Giant Branching Mary Semple Pink was used for this study. Seed for the test was sown March 1 and given the normal day length. One lot of plants was given 4 hours of additional illumination from April 7 to May 5 from a 100-watt Mazda lamp.

These plants were planted in the cloth house on May 6 from 2¼-inch pots at a distance of 10 inches by 10 inches. The plants were divided into four plots: Plot 1, short-day treatment and flower stems disbudded; Plot 2, short-day treatment, no disbudding; Plot 3, lighted in the seedling stage; Plot 4, normal. Short-day treatment was carried on the same as with chrysanthemums. The plants were covered with black cloth at 5 P. M. and the cloth was removed at 7:30 A. M. Shading was begun on July 1 and continued until August 1. The soil was fertilized with a 4-12-4 fertilizer, 3 pounds to 100 square feet, before planting and given two applications of ammonium sulfate after the flowers showed color. Table 7 gives the results of this test.

The variety, Giant Branching Mary Semple Pink, used in this study flowered 30 days earlier than the normal when given additional light in the seedling stage and 17 days earlier when plants were given the short-day treatment.

There was not a very great difference between those plants that had been disbudded and those not disbudded. The plants that had been disbudded had only one flower and were more satisfactory for floral arrangement. Those not disbudded had a small flower produced from the axis of most of the leaves of the stem, and this detracted from the appearance of the flower.

**TABLE 6.—The Effect of Shading on Asters**

| Variety | Number of plants per plot | Date shading began | Number of plants wilted | Date first cut | Date last cut | Days from first to last cut | Number of flowers cut | Average stem length | Average diameter | Average number of flowers per plant |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | *In.* | *In.* | |
| Royal Purple | 21 | 6/20 | .. ... | 7/6 | 7/19 | 14 | 268 | 10.0 | 2.0 | 13.0 |
| | 21 | 6/27 | ..... | 7/6 | 7/23 | 18 | 350 | 12.5 | 2.6 | 16.6 |
| | 21 | 7/4 | .... . | 7/6 | 8/1 | 27 | 233 | 14.8 | 2.3 | 11.1 |
| | 21 | Check | .. .... | 7/6 | 8/8 | 33 | 300 | 16.6 | 2.3 | 14.3 |
| Imbricated Rose (pompon) | 21 | 6/20 | 3 | 7/6 | 7/23 | 18 | 350 | 9.8 | 1.3 | 19.4 |
| | 21 | 6/27 | 15 | 7/11 | 8/1 | 22 | 118 | 11.1 | 1.1 | 19.6 |
| | 21 | 7/4 | ..... | 7/11 | 8/1 | 22 | 400 | 13.0 | 1.3 | 19.0 |
| | 21 | Check | 2 | 7/11 | 8/8 | 29 | 330 | 13.6 | 1.5 | 17.0 |
| Royal Shell Pink | 21 | 6/20 | ..... | 7/15 | 8/3 | 20 | 330 | 14.0 | 2.6 | 15.7 |
| | 21 | 6/27 | 1 | 7/19 | 8/3 | 16 | 303 | 16.0 | 2.5 | 15.0 |
| | 21 | 7/4 | ..... | 7/19 | 8/8 | 21 | 243 | 15.8 | 2.7 | 11.5 |
| | 21 | Check | ..... | 7/26 | 8/14 | 20 | 184 | 21.7 | 3.3 | 9.0 |
| Royal White | 21 | 6/20 | 1 | 7/19 | 8/3 | 16 | 233 | 14.0 | 2.4 | 11.6 |
| | 21 | 6/27 | ..... | 7/19 | 8/3 | 16 | 234 | 16.2 | 2.3 | 11.1 |
| | 21 | 7/4 | 1 | 7/26 | 8/8 | 14 | 180 | 17.2 | 2.5 | 9.0 |
| | 21 | Check | ..... | 8/1 | 8/17 | 17 | 165 | 22.0 | 2.7 | 8.0 |
| Ball's Deep Rose | 21 | 6/20 | 1 | 7/15 | 7/23 | 9 | 210 | 15.0 | 2.5 | 10.5 |
| | 21 | 6/27 | 4 | 7/19 | 7/30 | 12 | 171 | 18.2 | 2.3 | 10.0 |
| | 21 | 7/4 | ..... | 7/26 | 8/3 | 9 | 169 | 19.0 | 2.5 | 8.0 |
| | 21 | Check | ..... | 7/28 | 8/11 | 15 | 173 | 25.0 | 2.9 | 8.2 |
| American Branching Azure Blue | 28 | 6/20 | ..... | 7/15 | 8/8 | 25 | 237 | 17.3 | 2.4 | 8.4 |
| | 21 | 6/27 | ..... | 7/15 | 8/8 | 25 | 209 | 20.4 | 2.5 | 10.0 |
| | 28 | 7/4 | 2 | 7/28 | 8/14 | 18 | 179 | 21.3 | 2.7 | 7.0 |
| | 28 | Check | ..... | 8/1 | 8/17 | 17 | 176 | 28.0 | 3.0 | 6.3 |
| Crego Deep Pink | 28 | 6/20 | 1 | 7/15 | 7/30 | 16 | 287 | 16.0 | 3.0 | 10.6 |
| | 21 | 6/27 | 1 | 7/23 | 7/30 | 7 | 160 | 17.1 | 2.7 | 9.0 |
| | 28 | 7/4 | 1 | 7/23 | 8/8 | 16 | 195 | 21.0 | 3.0 | 7.2 |
| | 28 | Check | ..... | 7/28 | 8/14 | 18 | 153 | 23.2 | 3.3 | 5.5 |

**TABLE 7.—Short-day Treatment on Asters, Variety Giant Branching Mary Semple Pink**

| Treatment | Average number of flowers per plant | Average flower diameter | Average stem length | Date of first cut | Date of last cut |
|---|---|---|---|---|---|
| Plot 1. Shaded, disbudded ..... | 9.43 | 2.37 | 14.59 | July 27 | Aug. 12 |
| Plot 2. Shaded ..... | 9.19 | 2.35 | 15.64 | July 28 | Aug. 12 |
| Plot 3. Additional light as seedlings..... | 7.81 | 3.00 | 7.92 | July 14 | Aug. 22 |
| Plot 4. Normal day length..... .... | 3.16* | 2.48 | 12.08 | Aug. 13 | Aug. 22* |

*Removed before all flowers open because of insects.

## *ADDITIONAL LIGHT AND SHADING ON ASTERS*

A variation in the treatment of asters was made in 1935 and 1936. In 1935 seven varieties of asters were used. They were started April 1 and set out May 17 and 18, spaced 11 by 12 inches. Four and one-half-foot beds were used in a cloth house covered with a yellow cloth. A portion of each variety received 4 hours of additional light from 100-watt lamps for a period of 2

weeks (mean light intensity, 5 foot-candles) just before planting. One bed served as a check receiving the normal light period; one was shaded with black cloth from 5 P. M. to 7 A. M. from June 25 until all buds were showing color; the other bed was treated in the same manner, except that shading was not begun until July 2. The plants were grown in the usual commercial manner. The results secured are given in Table 8.

In 1936 an experiment was conducted to obtain further data on the value of shading asters, as well as the value of additional light while the plants were still in the seedling stage. Eight varieties of asters were used. Seed was sown on March 15, and the seedlings were potted March 26. On May 15 the plants were planted in the cloth house from 2½-inch pots. During their growing season they received the normal treatment of fertilizing, watering, staking, and spraying. The plants were divided into four plots: Plot 1, seedlings lighted March 27 to May 15 and shaded June 24 to July 28; Plot 2, seedlings lighted March 27 to May 15; Plot 3, shaded July 2 to July 28; Plot 4, normal. Additional light was supplied for 4 hours (6 P. M. to 10 P. M.) daily from 40-watt lamps from the time of potting until planting in the cloth house.

The lamps were suspended over the bench 2 feet above the plants and 4 feet apart. This spacing is sufficient to cover an area of about 15 square feet of bench space, with benches 4 to 5 feet wide. The day was lengthened to 16 hours, so that in late April and the first part of May, just before planting, the light was not applied until 6:30 P. M. because of the increase in the normal daylight period.

The asters were shaded with the black cloth shade, Ohio Style No. 375. The plants were covered at 5:00 P. M., and the shade was removed at 7:00 A. M. The results obtained are given in Table 9.

### *ADDITIONAL LIGHT TREATMENT OF ASTER SEEDLINGS*

This study was conducted to determine the value of the additional light treatment for aster culture under cloth. For this study the variety Royal White was used. Seed for this experiment was sown March 1, and after potting the plants were divided into 4 plots. Plot 1 received an additional illumination from March 15 to May 5; Plot 2, additional illumination from March 25 to May 5; Plot 3, additional illumination from April 7 to May 5; and Plot 4 received the normal day length of that season of the year. An additional illumination period of 4 hours was supplied these plants from 100-watt light bulbs.

On May 6 these plants were planted in the cloth house from 2¼-inch pots and given the regular cultural treatments of spraying, staking, and watering. Plants were placed 10 inches by 10 inches. The soil was given an application of a 4-12-4 fertilizer, 3 pounds to 100 square feet, before planting and one of ammonium sulfate, 1 ounce to 2 gallons, when color showed in the flowers. Table 10 gives the results of this test.

The results in Table 10 show that additional light in the seedling stage produced flowers 13 days ahead of normal. There was no appreciable difference in the stem length.

**TABLE 8.—Effect of Additional Light and Shading on Asters**

| Treatment | Variety | Date of first bloom | Dates of heaviest production | Average stem length | Average flower diameter | Flowers per plant |
|---|---|---|---|---|---|---|
| | | | | *In.* | *In.* | |
| Check: Thirty plants of each variety | Ball's Deep Rose | July 25 | Aug. 7–15 | 26.1 | 2.71 | 6.36 |
| | Ball's Early White | Aug. 3 | Aug. 19–25 | 29.1 | 2.55 | 7.60 |
| | American Branching Azure Blue | July 29 | Aug. 15–25 | 28.8 | 2.49 | 7.13 |
| | Aurora Golden Sheaf | Aug. 20 | Aug. 25–28 | 24.7 | 2.34 | 4.83 |
| | Imperial Semple Pink | Aug. 7 | Aug. 20–27 | 26.4 | 3.03 | 8.13 |
| | Royal Shell Pink | Aug. 3 | Aug. 15–25 | 16.2 | 2.75 | 11.96 |
| | Crego Blue Flame | July 26 | Aug. 15–22 | 25.4 | 3.17 | 7.36 |
| Shaded* June 25 Thirty plants of each variety | Ball's Deep Rose | July 20 | July 22–26 | 26.2 | 2.33 | 6.50 |
| | Ball's Early White | July 25 | July 20–31 | 15.7 | 2.10 | 8.66 |
| | American Branching Azure Blue | July 26 | July 30–Aug. 5 | 23.9 | 2.39 | 7.73 |
| | Aurora Golden Sheaf | July 31 | Aug. 5–11 | 16.3 | 1.93 | 10.00 |
| | Imperial Semple Pink | July 25 | Aug. 1–5 | 18.7 | 2.54 | 8.80 |
| | Royal Shell Pink | July 23 | July 29–Aug. 3 | 13.0 | 2.17 | 10.60 |
| | Crego Blue Flame | July 18 | July 25–30 | 17.8 | 2.21 | 8.50 |
| Shaded* July 2 Thirty plants of each variety | Ball's Deep Rose | July 23 | July 29–Aug. 2 | 20.7 | 1.81 | 7.63 |
| | Ball's Early White | July 29 | Aug. 2–5 | 16.7 | 2.16 | 7.16 |
| | American Branching Azure Blue | July 29 | Aug. 5–9 | 28.1 | 2.56 | 6.70 |
| | Aurora Golden Sheaf | Aug. 5 | Aug. 9–12 | 13.7 | 2.07 | 6.30 |
| | Imperial Semple Pink | July 30 | Aug. 3–9 | 18.7 | 2.57 | 6.33 |
| | Royal Shell Pink | July 27 | Aug. 3–7 | 12.0 | 2.10 | 10.33 |
| | Crego Blue Flame | July 23 | July 29–Aug. 5 | 20.3 | 2.59 | 6.63 |
| Check: Lighted† Five plants of each variety | Ball's Deep Rose | July 25 | Aug. 9–11 | 25.8 | 2.74 | 8.6 |
| | Ball's Early White | July 29 | Aug. 15–19 | 26.3 | 2.32 | 4.0 |
| | American Branching Azure Blue | July 28 | Aug. 15 | 26.6 | 2.75 | 4.8 |
| | Aurora Golden Sheaf | Aug. 9 | Aug. 8–9 | 29.1 | 3.00 | 1.4 |
| | Imperial Semple Pink | Aug. 3 | Aug. 9–15 | 24.3 | 2.90 | 4.4 |
| | Royal Shell Pink | July 30 | Aug. 15–19 | 20.8 | 2.72 | 8.6 |
| | Crego Blue Flame | July 20 | Aug. 9–19 | 20.9 | 2.81 | 9.2 |
| Lighted† and shaded June 25 Five plants of each variety | Ball's Deep Rose | July 18 | July 22–24 | 16.7 | 2.63 | 8.0 |
| | Ball's Early White | July 23 | July 29–30 | 16.9 | 2.41 | 9.2 |
| | American Branching Azure Blue | July 18 | July 29–Aug. 1 | 19.8 | 2.73 | 6.6 |
| | Aurora Golden Sheaf | July 26 | Aug. 1 | 15.7 | 2.15 | 7.8 |
| | Imperial Semple Pink | July 24 | July 29–Aug. 1 | 16.8 | 2.66 | ..... |
| | Royal Shell Pink | July 23 | July 29–Aug. 1 | 15.1 | 2.43 | 8.4 |
| | Crego Blue Flame | July 18 | July 25–27 | 15.7 | 2.53 | 9.8 |
| Lighted† and shaded July 2 Five plants of each variety | Ball's Deep Rose | July 22 | July 29–30 | 19.3 | 2.29 | 5.2 |
| | Ball's Early White | July 29 | Aug. 2–3 | 13.3 | 2.32 | 7.2 |
| | American Branching Azure Blue | July 29 | Aug. 3 | 21.2 | 2.65 | 4.8 |
| | Aurora Golden Sheaf | July 29 | Aug. 1 | 18.3 | 2.58 | 1.2 |
| | Imperial Semple Pink | Aug. 1 | Aug. 1–3 | 18.6 | 2.66 | 2.4 |
| | Royal Shell Pink | July 29 | Aug. 1–3 | 14.3 | 2.29 | 3.4 |
| | Crego Blue Flame | July 3 | July 24–27 | 17.3 | 2.70 | 5.8 |

*Shaded from date shown until all buds showed color.

†Lighted 4 hours of additional light daily, 100-watt lamps for a period of 2 weeks before planting.

## TABLE 9.—Effect of Additional Light and Shading on Asters

| Varieties | Plot 1 Lighted March 27 to May 15 Shaded June 24 to July 28 | | | | | Plot 2 Lighted March 27 to May 15 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Date of first cut | Date of last cut | Av. number of flowers per plant | Av. stem length | Av. flower diameter | Date of first cut | Date of last cut | Av. number of flowers per plant | Av. stem length | Av. flower diameter |
| | | | | *In.* | *In.* | | | | *In.* | *In.* |
| Crego White | July 22 | Aug. 11 | 15.8 | 15.8 | 2.15 | Aug. 3 | Aug. 24 | 13.9 | 13.7 | 2.34 |
| American Branching Semple Pink | July 22 | Aug. 4 | 12.6 | 17.3 | 2.01 | July 24 | Aug. 24 | 10.3 | 26.0 | 2.94 |
| American Branching White | July 25 | Aug. 9 | 14.0 | 17.8 | 1.91 | Aug. 7 | Aug. 24 | 7.1 | 24.3 | 2.66 |
| American Branching Azure Blue | July 24 | Aug. 11 | 18.3 | 16.5 | 1.61 | July 24 | Aug. 21 | 16.4 | 19.0 | 2.03 |
| Aurora Golden Sheaf | July 24 | Aug. 4 | 9.6 | 15.7 | 1.57 | July 24 | Aug. 24 | 9.3 | 20.3 | 1.88 |
| Royal Shell Pink | July 9 | Aug. 4 | 2.3 | 16.7 | 1.18 | July 11 | Aug. 17 | 12.0 | 19.1 | 2.46 |
| Ball's Early Phlox | July 24 | Aug. 5 | 16.1 | 12.9 | 1.42 | July 25 | Aug. 24 | 15.2 | 14.9 | 1.64 |
| | Plot 3 Normal Shaded July 2 to July 28 | | | | | Plot 4 Normal | | | | |
| Crego White | July 31 | Aug. 11 | 10.9 | 15.7 | 2.73 | Aug. 5 | Aug. 24 | 6.6 | 17.8 | 2.54 |
| American Branching Semple Pink | Aug. 4 | Aug. 11 | 7.7 | 17.0 | 2.18 | Aug. 5 | Aug. 24 | 12.2 | 19.8 | 1.97 |
| American Branching White | July 21 | Aug. 11 | 10.5 | 14.2 | 2.13 | Aug. 5 | Aug. 21 | 6.0 | 19.0 | 2.81 |
| American Branching Azure Blue | July 30 | Aug. 11 | 11.3 | 27.1 | 2.31 | Aug. 5 | Aug. 24 | 1.5 | 20.5 | 2.14 |
| Aurora Golden Sheaf | Aug. 3 | Aug. 11 | 9.2 | 15.0 | 2.21 | Aug. 5 | Aug. 24 | 7.1 | 19.6 | 2.35 |
| Royal Shell Pink | July 27 | Aug. 9 | 10.1 | 17.9 | 2.76 | Aug. 5 | Aug. 24 | 9.8 | 17.7 | 1.93 |
| Ball's Early Phlox | Aug. 3 | Aug. 11 | 14.4 | 15.2 | 1.88 | Aug. 5 | Aug. 21 | 10.5 | 19.6 | 2.28 |

**TABLE 10.—Additional Light on Aster Seedlings, Variety Royal White**

| Treatment | Average number of flowers per plant | Average flower diameter | Average stem length | Date of first cut | Date of last cut |
|---|---|---|---|---|---|
| Lighted March 15–May 5 | 8.97 | 2.94 | 25.42 | July 6 | Aug. 10 |
| Lighted March 25–May 5 | 7.92 | 2.93 | 22.39 | July 6 | Aug. 10 |
| Lighted April 7–May 5 | 7.39 | 2.88 | 24.71 | July 6 | Aug. 11 |
| Normal day length | 4.85* | 2.72 | 25.47 | July 19 | Aug. 22* |

*Removed before finished flowering because of insects.

## *SUMMARY*

The earlier varieties of aster are less susceptible to wilt than the late varieties.

Some wilt-resistant strains show higher percentages of wilt than the non-resistant strains.

Queen of the Market and Early Royals were the only varieties that produced fair returns in the open. Aster yellows destroyed the remaining varieties.

Shading induced earliness in all varieties; that is, asters are short-day plants. In most varieties shading resulted in slightly smaller flowers and shorter stem length. This makes it necessary that asters, if they are shaded, be disbudded in the early stages; otherwise many laterals are produced along the flowering stems which reduce the length of the main stem and decrease the size of the flower.

Early shading of asters decreases the length of flower stem. Shading June 20, June 27, and July 4 showed a successive increase in stem length of all varieties for the late shading over the early shading. The average increase in stem length of the check over the June 20 shading for all varieties was 7.6 inches.

The later varieties, Crego Deep Pink, showed a decrease in number of flowers per plant for the late shading. The average decrease in number of flowers per plant for the above varieties between the June 20 shading and the check was two and eight-tenths flowers per plant. There was apparently very little influence of shading on the number of flowers per plant of the early varieties.

Late-flowering varieties showed a greater response to shading than the earlier varieties. The variety Royal Purple gave the first cut on July 6, regardless of when the shading began; whereas American Branching Azure Blue gave the first cut on July 15 when shaded June 20 and on July 8 when shaded July 4.

There was a slight increase in diameter of flower of the late shading over the early shading.

Shading should begin 7 to 8 weeks after planting; that is, asters planted May 18 should be shaded July 1 to 4 to get the best results in size and number of flowers combined with a reasonably early cut. For most of the early to medium early varieties, shading in late June gives the first cut around July 11 to 15; shading July 1 to 4 gives the first cut from the middle to late July; whereas the normal cutting date is from late July to early August.

With the exception of the variety American Branching White, those varieties which had been lighted as seedlings and shaded later flowered 6 to 18 days before those that were grown normally as seedlings and shaded.

Plants lighted in the seedling stage for 4 hours (6 P. M. to 10 P. M.) from March 27 until May 15 flowered 2 to 12 days earlier than normal. The variety Royal Shell Pink flowered 25 days earlier.

## EXPERIMENTS WITH CHRYSANTHEMUMS IN A CLOTH HOUSE

### *STANDARD CHRYSANTHEMUMS*

Standard chrysanthemums have not proved a satisfactory crop to grow under cloth. In 1933 a planting was made in the cloth house which grew very well, but poor blooms were produced that were unsalable. The moisture in the fall when they were in flower collected in the flower head and caused rotting and discoloration. Also, the flowers were discolored from the dirt that was washed down on them from the cloth by the rain. A protection of hotbed sash over the plants as they were coming into flower gave some help but was not entirely satisfactory.

### *DISBUDDED CHRYSANTHEMUMS*

Disbudded chrysanthemums have proved somewhat more satisfactory for culture under cloth than the standard chrysanthemums. In 1937, 13 varieties were grown under cloth, and from this 1 year's test it can be seen that they will do satisfactorily. If there is a market for this type they will furnish a desirable addition to the types ordinarily grown under cloth.

The plants in this study were planted in the cloth house on May 8 at a distance of 8 inches by 9 inches. The soil was given an application of a complete fertilizer at the rate of 3 pounds to 100 square feet previous to planting. After planting, a mulch of German peat, horticultural grade, was made on May 16. Applications of nitrophoska, 1 pound to 100 square feet, on July 23 and of ammonium sulfate, 1 pound to 100 square feet, on August 31 were given to those varieties showing color. These chrysanthemums were all given the short-day treatment from July 1 to September 11. Table 11 gives the results obtained.

**TABLE 11.—Disbud Chrysanthemums in the Cloth House**

| Variety | Average height of plants in inches | Average number of stems per plant | Average flower diameter | Date of first cut | Date of last cut |
|---|---|---|---|---|---|
| Princeton | 30.0 | 4.2 | 3.25 | Sept. 15 | Oct. 11 |
| Rolinda | 30.0 | 3.0 | 3.25 | Sept. 15 | Oct. 11 |
| Orchid Beauty | 30.0 | 4.1 | 3.25 | Sept. 9 | Oct. 7 |
| Lillian Doty | 22.0 | 5.6 | 2.75 | Aug. 30 | Sept. 27 |
| Melba | 23.0 | 3.9 | 3.25 | Sept. 2 | Sept. 20 |
| Pink Buckingham | 16.0 | 1.5 | 3.00 | Sept. 9 | Sept. 27 |
| Titian | 33.0 | 2.3 | 4.00 | Sept. 9 | Oct. 11 |
| Crimson Glow | 18.5 | 4.0 | 3.25 | Sept. 9 | Oct. 11 |
| Bronze Buckingham | 18.5 | 4.2 | 2.75 | Sept. 2 | Sept. 27 |
| White Mensa | 36.0 | 3.9 | 2.75 | Sept. 2 | Sept. 22 |
| Betty Rose | 35.0 | 3.6 | 3.50 | Sept. 2 | Oct. 7 |
| Valencia | 30.0 | 1.9 | 4.75 | Sept. 18 | Oct. 11 |
| Norma | 27.0 | 2.1 | 3.50 | Sept. 17 | Oct. 11 |

In the case of most of the varieties there was a satisfactory length of stem and number of flowers per stem although some did produce flowers that were poorly shaped (not recorded) and a few shoots that were blind. It is recom-

mended, however, that any one interested in trying out disbuds in the cloth house select those varieties that are known to be disbudded easily when grown under greenhouse conditions.

### *POMPONS AND EFFECT OF COLOR OF CLOTH*

Pompon chrysanthemums may be grown successfully in a cloth house if the plants are given the short-day treatment. Plants given the short-day treatment come into bloom before being damaged by the fall frosts. In 1932 and 1933 experiments were conducted with 11 different varieties. These experiments were conducted in the same cloth enclosure in which the asters were grown. Eleven varieties of pompon chrysanthemums were grown in plots under yellow cloth, white cloth, and out of doors. One-half of each plot was shaded with black sateen cloth from July 15 to August 30 to reduce the day length to 10 hours. The shade was applied at 5 P. M. and removed at 7 A. M. These plants were planted in the cloth house in the latter part of May from 2¼-inch pots. The plants were given the same cultural treatment as in a greenhouse. They received regular watering and fertilizing. The results of this experiment are given in Table 12.

The data in Table 9 show that earliness of flowering may be secured by using black shades. The difference in earliness of flowering under yellow and white cloths may be attributed partially to a heavier grade of black cloth under the yellow than under the white. Length of stem and quality of flower were a great improvement over those grown in open ground, and in addition to that, tarnished plant bug and other pests were eliminated from consideration. Outdoor plots showed so much damage and distortion from insect attacks that the flowers were not usable. The varieties Mensa and Maple Leaf did not respond as favorably as the other varieties.

The plots receiving normal treatment flowered very well under both cloths. The color in these plots was much more intense than that of the same varieties grown under glass. Planting pompons under cloth without shading with black sateen is not recommended. No heavy frosts occurred during the season until after the crop was cut, but if frosts had come before October 15, no crop would have been harvested from plants receiving normal treatment.

In 1933 a similar experiment was conducted in the cloth house, using white and yellow cloth. Five varieties of pompon chrysanthemums were used; three of the five varieties had been used the previous year. These were planted outdoors under cloth on May 26 from 2¼-inch pots. They were given the regular commercial culture and were shaded from July 8 to August 11. The results obtained are shown in Table 13.

Table 13 shows very little difference in growth under the two types of cloth. The cutting season lasted from September 1 to September 26.

From 960 plants a total of 298.25 bunches (13-ounce) was cut which sold at an average of 60 cents a bunch. This gave a total of $178.95. Approximately three plants made one bunch, and since about two plants cover 1 square foot of space, the return per square foot was about 36 cents.

**TABLE 12.—Effect of Shading on Pompons under Yellow Cloth, White Cloth, and Out of Doors**

| Variety | Date of cutting | | | | | | Average stem length | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Yellow | | White | | Open | | Yellow | | White | | Open | |
| | Short day | Normal day | Short day | Normal day | Short day | Normal day | Short day | Normal day | Short day | Normal day | Short day | Normal day |
| Capt. Cook | Sept. 13 | Nov. 1 | Sept. 19 | Nov. 1 | * | * | 39 | 53 | 39 | 50 | ..... | ..... |
| Ethel | Sept. 9 | Oct. 29 | Sept. 15 | Oct. 19 | Sept. 21 | * | 31 | 45 | 31 | 42 | 19 | ..... |
| Firebird | Sept. 28 | Oct. 21 | Sept. 17 | Oct. 21 | Oct. 6 | ..... | 32 | 42 | 25 | 40 | 21 | ..... |
| Irene | Sept. 5 | Oct. 19 | Sept. 9 | Oct. 19 | Oct. 6 | ..... | 30 | 42 | 31 | 40 | 12 | ..... |
| Izola | Sept. 15 | Oct. 1 | Sept. 28 | Oct. 1 | Oct. 29 | ..... | 30 | 41 | 28 | 41 | 20 | ..... |
| Maple Leaf | Sept. 28 | Oct. 31 | Sept. 28 | Oct. 31 | ..... | ..... | 29 | 40 | 30 | 40 | ..... | ..... |
| Mensa | Sept. 19 | Nov. 3 | Sept. 17 | Nov. 3 | ..... | ..... | 36 | 49 | 27 | 48 | ..... | ..... |
| Rodell | Sept. 7 | Oct. 14 | Sept. 9 | Oct. 14 | ..... | ..... | 31 | 42 | 26 | 40 | ..... | ..... |
| Silver Ball | Sept. 5 | Oct. 19 | Sept. 9 | Oct. 19 | Oct. 6 | ..... | 36 | 48 | 34 | 45 | 18 | ..... |
| Varsity | Sept. 9 | Oct. 25 | Sept. 16 | Oct. 25 | ..... | ..... | 31 | 47 | 29 | 45 | ..... | ..... |
| White Doty | Sept. 13 | Oct. 31 | Sept. 17 | Oct. 31 | Sept. 29 | ..... | 31 | 42 | 28 | 42 | 19 | ..... |

*Flowers were disfigured from attack by tarnished plant bug.

**TABLE 13.—Shading Pompon Chrysanthemums under Yellow and White Cloth**

| Variety | Number of plants | Length of stem | | Number of bunches cut* | |
|---|---|---|---|---|---|
| | | Yellow | White | Yellow | White |
| | | *In.* | *In.* | | |
| Uvalda | 96 | 31.0 | 28.0 | 28.50 | 31.00 |
| Varsity | 96 | 30.5 | 30.0 | 35.00 | 30.00 |
| Firebird | 96 | 34.5 | 34.0 | 27.25 | 32.00 |
| Rodell | 96 | 27.0 | 27.5 | 32.50 | 27.00 |
| Pink Dot | 96 | 32.5 | 33.0 | 26.50 | 28.50 |
| Total | | | | 149.78 | 148.50 |

*Weight of each bunch, 13 ounces.

## *SPACING DISTANCE OF POMPONS UNDER CLOTH*

Two different tests were conducted on chrysanthemums in the cloth house in 1935 and 1936. The first of these tests was to determine the proper distance of spacing for pompons grown under cloth and shaded. The data in Table 11 are the results secured in 1936. Four varieties were used: Ethel, Irene, Jewel, and Varsity. These were grown in ground beds and were spaced 7 by 8, 8 by 9, 9 by 9, and 12 by 12 inches. They were shaded from July 10 until September 15 and subjected to a 10-hour day. This was several weeks longer than necessary for most varieties, but was done because the variety Varsity was slow in forming flower buds.

The mums were planted on May 13 from 2¼-inch pots. They received the regular commercial culture of spraying and fertilizing. The plants were spaced so that the area of any one variety was the same in all plots but the number of plants varied according to distance of planting.

**TABLE 14.—Spacing Distance of Pompons, 1936**

| Variety | Distance of planting | Ounces cut per plant | Ounces cut per square foot | Plants per 9-ounce bunch | Date of first cut | Date of last cut |
|---|---|---|---|---|---|---|
| | *In.* | | | | | |
| Ethel | 7 x 8 | 4.05 | 10.42 | 2.20 | Sept. 9 | Oct. 1 |
| | 8 x 9 | 6.99 | 13.97 | 1.28 | Sept. 7 | Oct. 1 |
| | 9 x 9 | 5.25 | 9.00 | 1.71 | Sept. 7 | Oct. 1 |
| | 12 x 12 | 12.61* | 13.51* | .71 | Sept. 7 | Oct. 1 |
| Irene | 7 x 8 | 1.98 | 5.10 | 4.55 | Aug. 31 | Oct. 1 |
| | 8 x 9 | 4.26 | 8.53 | 2.11 | Aug. 31 | Oct. 1 |
| | 9 x 9 | 4.16 | 7.14 | 2.16 | Aug. 31 | Oct. 1 |
| | 12 x 12 | 8.11* | 8.69* | 1.11 | Aug. 31 | Oct. 1 |
| Jewel | 7 x 8 | 3.00 | 7.83 | 3.38 | Sept. 5 | Oct. 1 |
| | 8 x 9 | 5.44 | 10.89 | 1.65 | Sept. 5 | Oct. 1 |
| | 9 x 9 | 5.30 | 9.10 | 2.47 | Sept. 5 | Oct. 1 |
| | 12 x 12 | 7.66* | 7.81* | 1.17 | Sept. 5 | Oct. 1 |
| Varsity | 7 x 8 | 3.83 | 8.79 | 4.46 | Sept. 13 | Oct. 9 |
| | 8 x 9 | 6.22 | 12.44 | 1.45 | Sept. 11 | Oct. 9 |
| | 9 x 9 | 7.60 | 9.30 | 1.18 | Sept. 11 | Oct. 9 |
| | 12 x 12 | 10.94* | 11.15* | .825 | Sept. 11 | Oct. 1 |

*There is a slight difference between these two columns because the plants were planted slightly closer than 12 by 12.

This test was a continuation of a similar one carried on during the summer of 1935. The results obtained in 1936 and those of the year previous, although they varied slightly, would indicate that a planting distance of 8 by 9 inches would give the best production per square foot. Planting at a greater distance produced a larger number of stems and often much weaker ones with many small side shoots. In general, a pompon chrysanthemum will give the best flowers with not more than 6 to 7 stems per plant.

### *DATE OF LAST PINCHING BEFORE SHADING*

The second test with pompons under cloth was an attempt to correlate the date of the last pinch and production under a reduced daylight period. The plants were planted and cared for as those in the preceding experiment. They were planted 8 by 9 inches and shaded from July 10 to September 15. The variety Maiden's Blush was slow in developing its flower buds and it was necessary to continue the application of the shade. The variety Clara Jameson produced good flowers when shaded, but the stems were rather weak and spindly. It is a good variety but should not be shaded. The data secured in 1936 are presented in Table 15.

**TABLE 15.—Date of Pinching**

| Variety | Date of last pinch | Ounces cut per plant | Ounces cut per square foot | Plants per 9-ounce bunch | Date of first cut | Date of last cut |
|---|---|---|---|---|---|---|
| Cora Peck Buhl ... | June 26 | 2.98 | 5.97 | 3.02 | Sept. 11 | Oct. 10 |
| | July 2 | 3.79 | 7.59 | 2.36 | Sept. 9 | Oct. 10 |
| Nuggets..... | June 26 | 5.81 | 11.40 | 1.55 | Sept. 10 | Sept. 24 |
| | July 2 | 6.75 | 13.24 | 1.33 | Sept. 10 | Oct. 1 |
| Letitia ..... | June 26 | 6.54 | 13.09 | 1.37 | Sept. 5 | Oct. 1 |
| | July 2 | 6.20 | 12.41 | 1.45 | Sept. 5 | Oct. 1 |
| Clara Jameson.... | June 26 | 6.05 | 12.10 | 1.48 | Sept. 11 | Oct. 1 |
| | July 2 | 5.91 | 11.83 | 1.52 | Sept. 9 | Oct. 5 |
| Mary Lennon Hall. | June 26 | 4.78 | 9.56 | 1.88 | Sept. 9 | Oct. 5 |
| | July 2 | 1.96* | 3.93* | 4.59* | Sept. 13 | Oct. 9 |
| Maiden's Blush.... | June 26 | 3.81 | 7.63 | 2.35 | Sept. 21 | Oct. 10 |
| | July 2 | 3.42 | 6.85 | 2.62 | Sept. 21 | Oct. 10 |
| Minong..... | June 26 | 5.45 | 10.91 | 1.65 | Sept. 5 | Sept. 24 |
| | July 2 | 4.34 | 8.68 | 2.08 | Sept. 5 | Sept. 24 |

*This plot had a very severe attack of wilt that accounts for low production.

This experiment was the continuation of a similar one conducted in the summer of 1935. From the results in both years' work it is difficult to draw definite conclusions. In the varieties used, which included Nubian and Sea Gull in 1935, it may be said that pinching 1 week before the reduced light period is begun is safe for satisfactory production and quality.

### *MULCH STUDIES ON POMPON CHRYSANTHEMUMS*

This study was conducted in 1937 to determine more fully the value of mulches on crops grown under cloth. The value of mulches on crops out of doors is realized, but less is known of their value in a cloth house where there

are less drying out of the soil, greater humidity, and a reduced light intensity. Four beds (63 feet by 4 feet 4 inches) in the cloth house were devoted to this test. Thirteen varieties of pompon mums were used. The plants were planted on May 7 at a distance of 8 inches by 9 inches and mulches were applied on June 4. Previous to planting, the soil was given an application of a 4-12-4 fertilizer at the rate of 3 pounds to 100 square feet and two applications of nitrophoska, June 26 and July 23, at the rate of 1 pound per 100 square feet. The plants were given the short-day treatment from July 1 to September 11. The results of this test are shown in Table 16.

**TABLE 16.—Mulch Studies on Pompon Chrysanthemums**

| Variety | Plot 1 | | Plot 2 | | Plot 3 | | Plot 4 | |
|---|---|---|---|---|---|---|---|---|
| | No mulch | | Miscellaneous mulches, 1 inch of Florida humus | | German peat, 1 inch, poultry litter grade | | German peat, 1 inch, horticultural grade | |
| | Average height of plant | Average number of ounces per plant | Average height of plant | Average number of ounces per plant | Average height of plant | Average number of ounces per plant | Average height of plant | Average number of ounces per plant |
| | *In.* | | *In.* | | *In.* | | *In.* | |
| Cavalier* | 35.0 | 0.50 | 43.0 | 2.08 | 42.0 | 3.33 | 39.0 | 2.16 |
| Granny Scoville* | 28.0 | 5.76 | 34.5 | 4.15 | 31.0 | 3.29 | 32.0 | 3.37 |
| Crimson Splendor | 30.0 | 6.50 | 34.0 | 6.88 | 34.0 | 6.69 | 36.0 | 7.33 |
| Irene | 25.0 | 4.39 | 30.0 | 5.03 | 31.0 | 4.18 | 32.0 | 4.14 |
| | | | 1-inch mulch of alfalfa chaff | | | | | |
| Yellow Dot | 33.0 | 5.34 | 36.0 | 5.23 | 33.5 | 5.20 | 35.0 | 5.25 |
| Nellie Kleris | 33.0 | 3.50 | 33.0 | 3.44 | 31.0 | 3.47 | 32.0 | 2.37 |
| Cora Peck Buhl | 28.0 | 4.11 | 36.0 | 4.91 | 20.0 | 4.26 | 30.0 | 4.32 |
| | | | 1-inch mulch of wood shavings | | | | | |
| Sea Gull | 32.0 | 6.02 | 36.0 | 5.58 | 35.0 | 5.08 | 35.0 | 5.13 |
| Ethel | 29.5 | 5.94 | 34.0 | 6.25 | 31.0 | 5.00 | 31.0 | 5.13 |
| Blanche | 30.0 | 5.64 | 35.0 | 6.50 | 34.0 | 5.46 | 34.0 | 5.10 |
| Bronze Buckingham | 23.0 | 3.80 | 25.0 | 5.10 | 24.0 | 4.92 | 23.0 | 2.86 |
| Aloma | 33.0 | 4.53 | 35.0 | 5.18 | 33.5 | 4.62 | 35.0 | 5.54 |
| Pink Buckingham | 20.0 | 3.00 | 22.0 | 3.50 | 21.0 | 3.59 | 21.0 | 3.25 |

*These varieties did not keep satisfactorily after cutting and were not all entirely recorded. They were also badly infested with foliar nematodes.

From Table 16 we see that with one exception the average height of the plants was greater where they were mulched. They varied from 2 inches to 8 inches taller, depending upon the variety. In most instances there was a fraction of an ounce to over an ounce greater average weight of flowers produced per plant on those plants that were mulched. There was no uniform variation between the various types of mulches. This test indicates that mulches are of value in producing taller and heavier plants of pompons under cloth. Their property of preventing the soil from drying out and maintaining a more uniform soil moisture and cooler soil temperature probably accounts for these differences.

## *SUMMARY—CHRYSANTHEMUMS UNDER CLOTH*

Pompon chrysanthemums may be grown under cloth enclosures satisfactorily.

Pompons respond to shading in the cloth house. Normal treatment is not recommended.

The flower stem length and quality are better under cloth than out of doors.

The color of the cloth has little or no effect on the quality and quantity of flower production.

The most satisfactory distance of planting for quality flowers is 8 by 9 inches.

The last pinch of pompons previous to shading should not be made less than 1 week before, although varietal differences exist.

As they come into flower, standard chrysanthemums grown in a cloth house and shaded must be protected from the rains by hotbed sash or similar material. Paraffined cloth is also useful for this purpose.

Disbudded chrysanthemums are more satisfactory under cloth than standard chrysanthemums. They do not need extra protection from rain and they give satisfactory flowers with little more effort than necessary for standard pompons.

A mulch of some organic material, such as peat, alfalfa chaff, or wood shavings, produces greater stem length and slightly greater average flower production per plant.

## ANNUAL CUT FLOWERS UNDER CLOTH

The usefulness of the cloth house is not limited to the growing of asters. Many commercial florists are finding it valuable for a large number of summer cut flowers. The following experiments have been carried on since 1932.

In 1932 the effect of the color of the cloth on the growth of the plant was studied. This experiment was carried out in the same house as the chrysanthemum and aster tests mentioned previously. Thirteen varieties of annuals were planted under three treatments—white cloth, yellow cloth, and out of doors. These were planted from 2½-inch pots in the latter part of May. The results of this experiment are given in Table 17.

These data indicate that although the production was somewhat variable, the length of stem and the diameter of flowers were greater in plots under cloth. The stiffness of stem and the quality of the flowers under cloth were superior to those grown outdoors, and the coloring of the flowers was more intense.

A similar experiment was carried out in 1933 under similar conditions with the following crops. The results are shown in Table 18.

In addition, other crops may be grown under cloth. In the vicinity of Columbus sweet peas do fairly satisfactorily under cloth; the stem length is rather short, but the flowers are of a good quality. Sweet peas will produce even better flowers farther north where the weather is somewhat cooler.

The marigold Dixie Sunshine makes a satisfactory cut flower when it is shaded as the chrysanthemum. When it is grown normally it will not flower until October 1; whereas plants which were shaded July 10 to September 15 flowered September 2.

Pompon dahlias grown under cloth are not very satisfactory. They grow tall but do not produce enough blooms to be a profitable crop for cloth houses.

Gerberas make an excellent crop under cloth. Seedlings planted from 2½-inch pots on May 31 produced large clumps by fall. These were lifted and grown on in the greenhouse for winter bloom. They produced fine large blooms beginning in August and continued on after they had been lifted and removed to the greenhouse.

**TABLE 17.—Effect of Color of Cloth on Miscellaneous Annuals**

| Variety | Average number of flowers per plant | | | Average stem length (inches) | | | Average flower diameter (inches) | | |
|---|---|---|---|---|---|---|---|---|---|
| | Yellow cloth | White cloth | Open | Yellow cloth | White cloth | Open | Yellow cloth | White cloth | Open |
| *Antirrhinum majus* var. Cheviot Maid | 18.0 | 26.8 | 20.0 | 14.5 | 16.8 | 10.7 | ..... | ..... | ..... |
| *Antirrhinum majus* var. Rose Queen | 9.9 | 8.7 | 7.3 | 13.6 | 14.6 | 9.7 | ..... | ..... | ..... |
| *Calendula officinales* var. Ball's Gold | 9.7 | 10.0 | 7.0 | 21.2 | 17.8 | 11.2 | 2.3 | 2.3 | 2.0 |
| *Centaurea suaveolens* | 16.8 | 18.5 | 17.4 | 9.5 | 8.7 | 8.2 | 1.6 | 1.5 | 1.5 |
| Annual Chrysanthemum | 18.9 | 34.0 | 11.1 | 16.1 | 13.9 | 8.2 | 1.8 | 2.0 | 1.3 |
| *Crepis* | 69.1 | 71.2 | 29.3 | 12.2 | 12.5 | 8.0 | 1.5 | 1.3 | 1.0 |
| *Cynoglossum amabile* | 6.9 | 7.8 | 8.8 | 29.0 | 25.7 | 21.6 | ..... | ..... | ..... |
| Dahlia var. Jersey Beauty | 21.7 | 33.0 | 13.0 | 14.3 | 7.8 | 7.0 | 6.5 | 4.5 | 3.0 |
| Dahlia var. Princeps Victoria | 41.8 | 37.0 | 9.7 | 11.2 | 11.5 | 6.0 | 3.0 | 3.0 | 2.5 |
| *Pentstemon gloxinioides* var. Red Sensation | 5.3 | 5.7 | 1.1 | 28.5 | 29.6 | 16.0 | ..... | ..... | ..... |
| Scabiosa Azure Fairy | 25.1 | 40.8 | 25.3 | 10.8 | 12.2 | 10.0 | 1.9 | 1.9 | 1.5 |
| *Tagetes erecta* var. Guinea Gold | 72.4 | 75.5 | 40.8 | 16.9 | 14.6 | 8.5 | 3.0 | 2.1 | 2.0 |
| Zinnia elegans | 12.5 | 8.4 | 10.1 | 25.1 | 28.2 | 10.9 | 3.1 | 3.6 | 2.3 |

**TABLE 18.—Effect of Cloth Enclosures on Miscellaneous Crops**

| Plant | Average flowers per plant | | Average stem length | | Average diameter | |
|---|---|---|---|---|---|---|
| | Yellow | White | Yellow | White | Yellow | White |
| | | | *In.* | *In.* | *In.* | *In.* |
| Hardy Carnation | 6.6 | 5.2 | 12.09 | 11.54 | ..... | ..... |
| Annual Chrysanthemum, Northern Star | 8.0 | 5.4 | 16.13 | 16.97 | ..... | ..... |
| Dahlia Pompon | 14.0 | 16.4 | 13.58 | 13.82 | ..... | ..... |
| Delphinium (second crop), total number of flowers | 62.0 | 44.0 | 21.30 | 21.60 | ..... | ..... |
| Marigold, Lemon Queen | 28.4 | 20.1 | 17.73 | 18.80 | 2.03 | 2.03 |
| Snapdragon, Gotalund | 19.7 | 14.0 | 14.52 | 16.00 | ..... | ..... |
| Snapdragon, Snowflake | 10.0 | 11.9 | 19.93 | 19.35 | ..... | ..... |
| California Giant Daffodil Zinnia | 14.7 | 12.4 | 18.70 | 17.50 | 2.55 | 2.58 |

## *SNAPDRAGONS*

Four varieties of winter-flowering snapdragons were grown successfully under cloth during the summer growing season of 1937. Seedlings from 2¼-inch pots were planted on May 20 directly to ground beds from the greenhouse. The soil had been given a 4-12-4 fertilizer at the rate of 3 pounds to 100 square feet. The plants were planted 10 inches by 10 inches. The quality of the flowers was satisfactory for summer-grown snapdragons, and snapdragons grown this way would be very useful for the retail florist. The results secured are given in Table 19.

**TABLE 19.—Snapdragons under Cloth**

| Variety | Average number of flowers per plant | Average stem length |
|---|---|---|
| | | *In.* |
| Marion's White | 8.05 | 17.6 |
| Canary Yellow | 9.10 | 13.3 |
| Cheviot Maid | 8.90 | 12.8 |
| Goffs Grandview | 4.80 | 15.7 |

## *SUMMARY*

Zinnia, marigold, annual chrysanthemum, pentstemon, snapdragon, calendula, cynoglossum, and scabiosa flower extremely well under both types of cloth.

Dahlias should be grown under an enclosure at least 8 feet in height. The production is not great enough to warrant a cloth house. Pompon dahlias do not produce enough bloom to make them a profitable crop for the cloth house.

Annuals growing under cloth need supports similar to those used in greenhouses for carnations or snapdragons.

The color of the flowers is more brilliant under the cloth.

Some annuals grown under cloth are more valuable for the retail grower than the wholesaler, as prices on the wholesale market do not justify this extra cost of growing.

## ROSES UNDER CLOTH

Roses grown under cloth during the summer offer the retail florist an opportunity of having a source of supply at his own place. In 1935, plants of the variety Premier Supreme that had been forced in a commercial greenhouse for 5 years were cut back to within 8 inches of the soil surface and planted 12 by 12 inches on May 10. They were syringed several times daily until new breaks were well developed. They were fertilized with a complete fertilizer about every 2 weeks after June 26. The first crop was pinched to allow the plants to become better established. Records were taken of the second and third crops. The average production was 7.78 blooms per plant. The average stem length was 11.65 inches. The color and quality of flowers were superior to those grown under glass during the same period.

These roses were allowed to remain over winter protected with a mulch of strawy manure. In 1936, these plants again flowered. In addition to these, three other varieties of roses that had been forced in the greenhouse for several years were planted. The varieties planted were: Talisman, Briarcliff, and Yellow Joanna Hill. The variety Yellow Joanna Hill, which was forced in the greenhouse, was removed in December and for lack of space in the greenhouse or a frame, was heeled in out of doors. On April 29 these plants were planted in the cloth house. The varieties Briarcliff and Talisman were forced in the greenhouse during the winter. They were dug from the bench, cut back, and planted immediately on May 15 and 19, respectively. The plants were planted 12 by 12 inches.

During the season the plants were given applications of ammonium sulfate and one application of potash in June. The plants were pinched in early July to allow them to build up and produce longer stems.

It was necessary to keep the plants dusted in order to control Black Spot.

The records given in Table 20 were obtained.

**TABLE 20.—Production of Roses under Cloth, 1936**

| Variety | Number of plants | Total number of flowers | Average number per plant | Average stem length in inches |
|---|---|---|---|---|
| Premier Supreme | 80 | 662 | 8.27 | 11.8 |
| Talisman | 88 | 584 | 6.62 | 14.2 |
| Yellow Joanna Hill | 80 | 292 | 3.65 | 9.7 |
| Briarcliff | 80 | 382 | 4.77 | 14.6 |

The quality of the roses produced was superior to that of roses grown under glass at the same period.

### *RAISED VERSUS GROUND BEDS FOR ROSES UNDER CLOTH*

In 1937 a comparison was made of raised and ground beds for growing roses under cloth. The plants were divided into 3 plots. Plots 1 and 2 were in a raised bed and Plot 3 was on the ground level. The raised bed was made by using 12-inch redwood planks set about 2 inches into the ground. In preparing for Plot 1, the soil was excavated to about 2 inches below the board, and then a layer of cinders about 4 inches thick was placed in the bottom of the bed. Eight inches of soil that had been composted with manure were placed on top of this. Into this soil was worked superphosphate at the rate of 5 pounds to 100 square feet and a 4-12-4 fertilizer at the rate of 2 pounds to 100 square feet. Plot 2 was prepared in the same way, except that no cinder drainage was provided. Plot 3 was prepared on the ground level; about 1 inch of manure was worked into the upper 6 inches of the soil and fertilizers were applied at the same rate as in the other plots. The plants were planted 12 inches by 12 inches on April 17. The varieties Hollywood and Talisman (new) were direct from the greenhouse where they had been forced for several years. These plants were cut back to about 6 inches above ground after planting. The other plants were roses that had been forced in the greenhouse for several years and then grown in the cloth house, the varieties Briarcliff and Talisman (old) for 1 year, Premier Supreme, for 2 years.

A mulch of well-rotted manure was made on June 11 to all plants except one-half of the Hollywood in each plot; these were mulched with 1 inch of German peat. Following this treatment two applications of nitrophoska were made at the rate of 1 pound to 100 square feet on June 28 and July 19. The results obtained are given in Table 21.

The growth of the plants was very satisfactory in all cases. Because of the excessive amount of rain and high humidity during the early summer of 1937 there was some trouble from black spot of rose; it was controlled with sulfur dusts. The foliage and color of the flowers were equal to those grown in the greenhouse in the summer.

Stem rot also became troublesome, especially in Plot 2 where peat had been used as a mulch. Because of the injury produced and in some cases the death of the plant, the production was not as satisfactory as it might have been.

The results obtained seem to indicate that there is no beneficial effect of planting roses in a raised bed. Since all plots were situated on a naturally well-drained area, no added benefit was obtained from the additional drainage provided; however, under conditions where drainage is not very good, raised beds may prove very satisfactory.

**TABLE 21.—Raised versus Ground Bed for Roses under Cloth**

| Crop | Plot 1 | | Plot 2 | | Plot 3 | |
|---|---|---|---|---|---|---|
| | Raised bed with cinder drainage | | Raised bed with no drainage | | Ground bed | |
| | Average number of flowers per plant | Average stem length | Average number of flowers per plant | Average stem length | Average number of flowers per plant | Average stem length |
| | | *In.* | | *In.* | | *In.* |
| Hollywood* | 12.9 | 12.11 | 9.45† | 11.14 | ..... | ..... |
| Hollywood | 13.5 | 11.98 | 13.70 | 12.36 | 12.3 | 13.07 |
| Talisman (new) | 10.3 | 13.35 | 8.60 | 10.40 | 10.9 | 13.19 |
| Talisman (old) | 9.2 | 9.43 | 8.90 | 9.04 | 7.1 | 11.01 |
| Premier Supreme | 14.0 | 8.80 | 14.70 | 8.06 | 14.9 | 9.42 |
| Briarcliff | 10.3 | 9.55 | 11.30 | 9.18 | 11.5 | 9.71 |

*Peat mulch; remainder of plants with a manure mulch.
†Part of plants removed because of stem rot; others remained weakened.

**Fig. 5.—Roses under cloth in a raised bed Variety Premier Supreme in foreground**

### *FRANCIS SCOTT KEY ROSE UNDER CLOTH*

Since this variety is a desirable summer-flowering rose under greenhouse conditions, budded plants of this variety were planted in the cloth house on May 15 direct from the nursery storage. They were planted in a ground bed and given the same treatment as Plot 3 of the previous experiment. These plants were very slow in getting started and because of this did not give the production they should have when compared with the other varieties. They averaged 4.7 flowers per plant with a stem length of 8.76 inches. The quality of flowers was not as good as that of the other varieties tested.

## PERENNIALS UNDER CLOTH

### *EUPATORIUM*

Various perennials have been tried under cloth, but most of them flowered before the cloth was erected or shortly after; therefore no results of importance were obtained. One perennial that does very well is *Eupatorium coelestinum.* This may be grown in beds like those for asters, and the plants can be shaded from 5 P. M. to 7 A. M. with a black cloth. Shading should begin July 1 to 10 and continue until August 10 or 15. In this way they may be had in flower about 2 weeks ahead of the normal flowering period.

### *ROCK PLANTS*

During 1936, 27 varieties of rock garden or alpine plants were grown under cloth. Of these only the following plants were fairly satisfactory: *Asperula odorata, Inula royleana, Androsace sarmentosa, Alstroemus longuinosus, Mimulus luteas, Houstonia serphylifolium, Coronilla cappadoire.*

From this one season's tests, growing alpines under cloth would not seem to be practical or desirable. Many of those that were grown made satisfactory growth in the early part of the season but soon died during the hot weather of July and August.

### *PERENNIAL DELPHINIUM*

Perennial Delphinium has been grown to advantage in a cloth house. Seed of hybrid delphinium was sown February 1; the plants were potted into 2¼-inch pots and planted in the cloth house on May 20. These plants developed rapidly and produced fine spikes of blooms about 36 inches tall by the middle of July. After the plants had been allowed to produce seed, most of them produced a second crop of blooms by October 1.

## POT PLANTS UNDER CLOTH

The cloth house offers an ideal place in which to grow certain pot plants during the summer. Chrysanthemums, hydrangeas, gardenias, and kalanchoe have made excellent growth under cloth out of doors, but Cyclamen, *Calceolaria rugosa,* and Saintpaulia have not responded favorably.

### *POT CHRYSANTHEMUMS*

In 1935 the variety Ohio State and seedlings of Ohio State were grown in the cloth house. The plants were shifted from 2½-inch pots to 4-inch pots and these were plunged into a bed in the cloth house on May 25. They were

pinched about every week to develop bushy plants. The second week in July they were shifted to 6-inch pots. The third week in August they were lifted and brought into the greenhouse and shifted into 7- and 8-inch pots.

These plants made remarkable growth during the summer. They were strong; the stems were stiff and erect; and good foliage grew to the base of the plant.

### *HYDRANGEAS*

For several seasons, varieties of *Hydrangea hortensis* have been grown under cloth successfully during the summer for forcing during the winter.

The plants from 2½-inch pots were set out on May 24. They were planted 12 by 12 inches and pinched during the first week of July. Because of the extremely heavy growth of these plants they were lifted the middle of August and potted in 6-inch pots. These plants were superior to those grown out of doors in the field or those grown in pots in a cold frame. There may be an objection that they grew a little tall for most forcing purposes. In order to overcome this they should be grown in pots and plunged into the soil. This will restrict the root growth and tend to produce shorter plants.

Where they were grown directly in the soil, they produced plants 13 to 16 inches high. This is too tall for satisfactory pot plants. Plants grown in pots were 8 to 10 inches in height. For the ordinary grower, however, culture in frames or the field would be more satisfactory.

### *KALANCHOE BLOSSFELDIANA*

Plants set in the cloth house on May 25 from 2¼-inch pots were larger and much stockier than those grown in the greenhouse. They were pinched twice during the summer and lifted on August 15.

### *GARDENIAS*

Gardenias (*Gardenia veitchi* and varieties) propagated in March were set out under cloth on May 24 in ground beds to which had been added a liberal application of German peat. On August 15 they were lifted and brought into a humid high-temperature greenhouse. During the summer they had made sufficient growth to require a 5-inch pot. The plants were in excellent condition for forcing during the winter. This method is recommended in order to secure the most growth in the shortest time.

Large pot gardenias also respond to planting in a cloth house. Plants from 5-inch pots were set in the cloth house May 25, lifted August 18, and placed in 7-inch pots. These plants had a stockier growth than those grown in the greenhouse. They had many more breaks or new shoots from the base of the plant and the foliage was slightly darker and heavier than that of corresponding plants grown in the greenhouse during the summer.

### *AZALEAS*

Azaleas respond well to summer treatment under cloth. Planted in suitable soil in well-drained beds these plants make exceptionally satisfactory specimens. The cloth should be removed in August to allow for proper flower bud development.

## NURSERY STOCK UNDER CLOTH

In 1933 both narrowleaf and broadleaf evergreens, rooted cuttings and potted plants, were set in beds in the cloth house and out of doors under lath shade. Thirteen rooted cuttings of *Juniperus sabina, Taxus cuspidata, Pyracantha coccinea lalandi, Cotoneaster henryana*; 25 rooted cuttings of *Juniperus chinensis pfitzeriana, J. horizantalis, Buxus sempervirens angustifolia, Thuja plicata, T. occidentalis pyramidalis*; and 25 plants from 2½-inch pots of *Lonicera nitida* and *Thuja occidentalis hoveyi* were planted in each of three plots, one under white cloth, one under yellow cloth, and one out of doors under lath shade.

Observations were made on October 2, and in only one case, *Thuja plicata,* were the plants grown outdoors under lath shade better than those grown under cloth. It may be stated that both narrowleaf and broadleaf evergreens will respond favorably under cloth, but the cost of the house probably is too great for the increase in growth that is obtained.

## MISCELLANEOUS PLANTS—STOCK PURPOSES

The cloth house offers an ideal way of carrying through the summer months certain greenhouse plants that ordinarily in central Ohio are lost because of the excessive heat. Plants of *Chrysanthemum fructescans* or Boston yellow daisy planted under cloth in May from 2¼-inch pots produce an abundance of cuttings by the middle of August. The same is true for *Pelargonium domesticum* or Martha Washington Geranium. Plants that are left over in the spring may be planted in late May or June and produce a bushy plant from which a large number of cuttings may be taken in August or September. It is possible that other plants will react in the same way.

## CONCLUSIONS

The cloth house offers the commercial florist an opportunity of producing during the summer flowers of superior quality. This is possible because of certain factors of light, temperature, humidity, soil, soil moisture, and soil nutrients; of these, light, temperature, humidity, and soil moisture are probably the most important. Light is perhaps the most variable of the factors with which we are concerned, and measurements show that under white cloth there is a reduction of light of 35 per cent and under yellow cloth, a reduction of 40 per cent. The temperature under cloth was slightly (5 to 8° F.) cooler. Temperature changes under cloth seemed to be somewhat slower and lagged ½ to 1½ hours behind those out of doors. The relative humidity under cloth is somewhat greater than outdoors but is important because of slower air circulation. Uniformity of soil moisture is a factor of importance.

1. The color of the cloth, from the data presented, has little or no influence on the plants.
2. Asters produce excellent flowers under cloth.
3. Asters respond to shading with black cloth shades from 5 P. M. to 7 A. M. Shading should begin 7 to 8 weeks after planting. Early varieties shaded in late June give the first bloom about July 10 to 15. Shading July 1 to 5 gives flowers July 20 to 30.
4. The use of additional light on asters in the seedling stage produced flowers 2 to 25 days before the normal plants; this varied with the variety.

5. Annual chrysanthemums, annual pentstemon, snapdragons, calendulas, cynoglossum, scabiosa, zinnia, marigold, and other annuals produce larger flowers with longer stems and better color under cloth.

6. Pompon chrysanthemums produce satisfactorily under a cloth house when shaded from 5 P. M. to 7 A. M. with black cloth. Flowers of excellent quality may be had in late September and early October. Normal treatment is not recommended.

7. The most satisfactory planting distance for pompon chrysanthemums for quality flowers is 8 by 9 inches.

8. The date of the last pinch of pompon chrysanthemums previous to shading should not be less than a week before shading is started for satisfactory results.

9. Roses under cloth produce flowers of a quality equal or superior to that of greenhouse-grown roses during the summer. Raised beds are not necessary if the soil is well drained.

10. Spring-flowering perennials and rock or alpine plants are not satisfactory for cloth-house culture.

11. Certain pot plants, such as pot chrysanthemums, gardenias, azaleas, and hydrangeas, may be grown under cloth and develop into strong, bushy plants. Hydrangeas may become too tall for most purposes when planted directly in the ground. Cloth should be removed from azaleas in August to ripen the wood and develop flowering buds.

12. Nursery stock of lining-out size of broadleaf and narrowleaf evergreens does not produce plants of enough superior quality to warrant the cost of a cloth house.

13. The cloth house may be used to carry over during the summer certain plants for stock or cutting purposes. Boston yellow daisies and pelargoniums have been very satisfactory.

14. Pompon chrysanthemums, asters, *Eupatorium coelestinum*, and Dixie Sunshine marigold respond to shading (5 P.M. to 7 A. M.).

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